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(57) Abstract

A home controller for controlling access to a home network which includes a plurality of modules. The home controller is used to draw together external communications networks, such as LANs and WANs, internal communications networks, such as a home network of modules, and applications which can reside on or across any of the above networks. The home controller provides for connectivity of the modules with the respective networks, and supports a wide variety of communications parameters and network technologies. The home controller is provided with an association table for storing information related to connections with any of the networks, and it uses that information for determining an appropriate connection for a module requesting a connection.

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MODULAR COMMUNICATIONS AND APPLICATIONS CONTROL SYSTEM

Background of the Invention

1. Field of the invention.

The present invention relates to an intelligent controller for controlling and setting up a plurality of devices in a network configuration. More specifically, the present invention relates to an intelligent home controller for determining if a requesting module can be set up in a network of modules utilized in a home environment.

2. Description of the related art.

Many homes are currently being fitted with smart systems which provide control of various home functions. For example, some homes now have smart energy modules, in which one can set a desired temperature for the home, and even provide different temperatures for different parts of the home at different times of the day. Additionally, one can program the energy controller to turn off all energy devices during a period when one is away from the home, and then automatically turn on all devices at the date one is supposed to return to the home. These conventional systems are typically stand-alone systems, and do not interface with other smart devices within the home.

Many homes today also have security systems, in which doors, windows, and other possible areas of entry are provided with security devices. These security devices will activate an alarm when the alarmed entry point is compromised. In such cases, an alarm is sent to an outside monitoring

system, which then calls the local police department to investigate the potential breaking into the home.

Many homes today are also equipped with cable television, via a cable connection to the home from a local cable provider. Cable systems are currently experimenting with interactive cable programming, in which persons can order merchandise and the like via a particular cable channel.

Most homes also are equipped with energy meter reading devices, which are used to determine the amount of energy (electric, gas, etc.) used by the persons in the home within a particular time period (i.e., one month). Typically, the reading of these meters is performed monthly by persons actually coming to the homes and reading the dials on the meters. Newer systems are available which provide direct readings to the utilities, such as that described in US Patents 4,241,237 and 4,455,453, invented by Parasevakos. These patents describe a remote meter reading system where each of a number of remote units initiate a callback at predetermined intervals to a central facility for billing and monitoring purposes. A central complex provides a digital instruction to each remote unit upon the completion of the data transfer.

US Patents 4,899,129, 4,899,217 and 5,101,191, invented by MacFadyen et al., describe an automated system for providing different services within a home, and a method of communicating digital data within the home using a high capacity data network. In MacFadeyn's system, however, all the devices are related to each other, in that they each control a different appliance within the home.

US Patent 4,332,980, invented by Reynolds et al., describes a multiple service system using telephone lines to supply data services to subscribers. The data services include meter reading, energy management, and digital data service. Reynolds' system uses the telephone local loop for providing these services, and it does not have any provisions for providing other communication links to the subscribers.

G. Hanover describes a network for use in an "intelligent" home, in his article published in IEEE Spectrum, October 1989, pgs. 48-49. In that article, G. Hanover describes the control of various types of devices in an electronic home, using a Consumer Electronics Bus (CEBus™).

V. Gilmore describes a network of smart devices in an "integrated automated educated" house, in her article published in Popular Science, June 1990, pgs 104-107. In that article, V. Gilmore describes using a bus standard being developed by the Electronic Industries Association to provide the connectivity between the "smart" devices within the house.

The above-described systems have a disadvantage in that all modules connected in their respective networks operate separately with respect to each other, and there is no available means to provide a hook-up of all of these devices in a "smart way". Further, there is no convenient way to allow for an additional module to hook up to an established home network of modules. Also, there is no convenient way for utility companies to obtain meter readings of homes by utilizing existing communication lines provided for other modules in the homes. Further, each of the above systems is limited to a particular bus structure that connects to all of the devices at any given time.

Summary of the Invention

The system according to the invention provides a simple and effective concentration of communications between the home and devices located therein and the external world, regardless of their differing communications requirements. Voice, data and video can be accommodated at differing communication parameters (e.g., speed or protocol) as required by the various applications being accommodated.

Presently, home telephone systems rely on delivery of services from their local operating company (LOC) to the home via their local copper loop. The inventive system provides an alternative to this presently used service by connecting applications in the home (such as a home telephone system and cable TV (CATV) system) to an alternative carrier or carriers. The subject invention allows connection to multiple networks, thereby allowing alternate paths to meet the homeowners needs. The connections can be via any wireless or wired network such as a radio frequency (RF) link to Personal Communications Services (PCS) , Specialized Multi-channel Radio (SMR), and Interactive Video and Data Services (IVDS) networks, a fiber optic link, a local cable television (CATV), or a LOC's copper loop. For the purposes of this document, wide area network (WAN) refers to all communications external to the home. The selection of a path can be data context and content sensitive.

The subject invention is applicable to communication networks in general. Most current telemetry devices accept inputs from one source, or at most a like group of sources. This data then may be stored, or not, before being sent over a predetermined communications network to a designated

destination. On the other hand, the subject invention is able to accept inputs from other, dissimilar sources. The subject device is data content sensitive - in addition to store and forward capabilities, it can also manipulate the data and repackage it as required. Connectivity to multiple networks allows an alternate path to be selected to insure successful communication of the data, if the data priority warrants it.

The subject invention can be used in CATV distribution environment and supports bi-directional communications between an end-user device and devices attached by a cable company. The selection of a path can be data context and content sensitive. The present invention is equally suited at providing an alternative video distribution system and at facilitating access by multiple household applications to a high bandwidth carrier.

The subject invention includes a home controller system (HCS) which is connected to the outside world through one or more connections to WANs. The device can provide a telemetry capability for utility providers. It also can provide connectivity to one or more applications within the consumer's home. These applications could include energy management devices, alarm systems, voice telephones, CATV service, computer data network and data service connectivity.

A device, located at the residence, allows the resident and devices in the residence to transparently use multiple service providers which have been configured into the device.

The HCS allows for an integration of existing technology (external interfaces and perhaps modules) combined with new technology (new internal interfaces and connectivity arbitration) to create a novel, utilitarian device.

In accordance with the above advantages of the system according to the invention, there is described herein an apparatus for controlling access of a plurality of modules to a plurality of communication networks. The apparatus includes input/output means for receiving a request for connection signal from a module desiring to connect to a network. The apparatus further includes a data storage area for storing rules governing connections to the networks. Based on the stored rules, the apparatus, following the algorithm stored in a program storage area, initiates or denies connection to one of the networks.

There is also described herein a network of modules for use in a home environment. The network of modules includes a plurality of worker modules each providing a particular function in the home environment. The plurality of worker modules may include a child tracker worker module for determining a location of a child within a particular range with respect to the child tracker worker module, an energy management worker module for providing energy control of the home environment based on user-inputted commands, a home security worker module for monitoring a perimeter of the local environment and for providing an alarm indication upon detection of an object at the perimeter, and an energy worker module for receiving input from a particular energy meter within the home environment, and for collecting and outputting the received input at predetermined times. The network of modules may include an internal data bus connecting each of said worker modules. The

network of modules may include an associator module connected to the internal data bus and configured to provide control of one or more worker modules which desire to connect with another module via the internal data bus to provide an additional service in the home environment.

There is also described herein a method for determining access to a home network of modules. The method includes a step of sending an interrupt by a requesting module to a control module in the home network to request a connection to said home network. The method also includes a step of determining, at the control module, whether the request for connection can be made by referring to an association table which contains information related to available connections to said home network. Further, the method includes a step of sending either a connection allowed signal or a connection disallowed signal by the control module to the requesting module based on the determination made in the previous step.

Brief Description of the Drawings

For a description of a method and apparatus according to the invention, reference is made to the following description and accompanying drawings, in which:

Figure 1 is a schematic view illustrating a physical environment of the present invention;

Figure 2 is a schematic view illustrating an abstract environment of the present invention;

Figure 3 is a schematic block diagram depicting modules of the present invention;

Figure 4 is a block diagram of components of the associator module of the present invention;

Figure 5 is a block diagram of components of a worker module that can be utilized in the present invention;

Figure 6 is a block diagram of an example of various modules being used with the HCS of the present invention;

Figures 7A - 7D illustrate a flow diagram of a request for connection to a home network made by an originating module to the associator of the present invention;

Figure 8 illustrates data within the "association table" of the present invention; and

Figures 9A - 9F illustrate data within various particular "results tables" of the present invention.

Detailed Description of the Preferred Embodiment

Throughout the drawings and following description, like numbers are associated with like items. Figure 1 illustrates the external environment of the HCS in a preferred embodiment. The HCS 101 is shown as mounted on the exterior of a consumer's home 102, although it can just as well be mounted inside the home 102. An RF connection 103 to a data network provider 104 allows a communications path 105 to a variety of destinations, such as a utility 106. HCS 101 has the facility to monitor and provide a level of control over a utility provider's supply lines, 108 and 109, via meter 107. The telemetry data

gathered can be manipulated, stored, and forwarded to the utility 106, via the connection provided by link 103, network 104 and link 105. The utility 106 then can return energy management instructions to HCS 101, as required. For example, during very hot summer days, when many homes are utilizing their air conditioning units continuously over a period of time, the utility 106 can send a command to any or all of the homes within its jurisdiction to lower their energy consumption. This can be done, for example, by the utility company 106 sending a control instruction to each home to automatically turn off their respective air conditioning units for a 15 minute period for each hour during the peak demand period.

The HCS 101 can carry out these control instructions at the local level by interaction with the utility meter 107. If the utility meter 107 is a typical utility meter which is not capable of demand control, then this capability might be provided by a separate device. The utility 106 could just as easily be providing electrical power, natural gas, water, steam, telephone, video, data, computer connectivity, or any other metered product or service.

Figure 2 depicts some of the elements in Figure 1. The connection 206 to the WAN 203 could be an RF connection, as depicted in Figure 1 by 103, or it could be via a dedicated land-line, a local telephone subscriber loop, CATV fiber optic or coaxial cable, or any other available technology. The WAN 203 can be a network provided by a data network provider, a public telephone company, a private network, or any other means which will facilitate communications between HCS 101 and the intended points, such as the utility 106.

HCS 101 is shown as having a connection 205 to a utility meter 107. This connection 205 may be either wireless or wired. Those of ordinary skill in the art will recognize that "wired" means any of a variety of connections, such as fiber optic, coaxial cable, twisted pair, etc. The utility meter 107 could then provide HCS 101 with the usage data required for telemetry. The type of meter used for utility meter 107 would depend on the product or service being provided.

HCS 101 is shown as having a connection 207 (wireless or wired) to a household local area network (LAN) 204. LAN 204 could be CEBus™, Local Operating Network (LonWorks™), SMART HOUSE™, ethernet, arcnet, RS-232, IEEE-488, or any other readily available communications medium for use in a geographically limited area (e.g., consumer's home 102). LAN 204 can connect a variety of devices or applications in or around the consumer's home 102 to HCS 101, through which they will be able to access, and be accessed by, the outside world. An example of a device which could be connected to LAN 204 is an energy management device such as would be required if utility meter 107 does not have integral energy management capabilities. These connections are implemented by plug-in modules within HCS 101. Thus, HCS 101 is provided with the flexibility to grow and change as the availability and desire for different connections at a residence grow and change.

Figure 3 depicts major modules of HCS 101 and their respective connections. HCS 101 can be connected to meter 107, a WAN 203, and a household LAN 204, as shown in Figure 2. The benefits of the present invention assert themselves more fully when multiple WANs are installed, such

as second WAN 203'. Multiple LANs, such as second LAN 204', also can be supported.

At the heart of HCS 101 is an associator 307. Functions of the associator 307 may include overall system control and management, error recovery and fault recovery. One of the functions of the associator module 307 is to act as a resource arbitrator for the HCS 101 and communicate with the other installed modules via an internal home controller (HC) bus 308. The HC bus 308 can be either a wired bus or the HCS 101 may communicate with the other modules via wireless links (i.e., rf signals), in which case, each device is provided with an antenna and a transceiver for communicating with other modules.

Three types of interface modules are depicted: utility module 309 and application module 312, WAN modules 310 and 310', and LAN modules 313 and 313'. These interface modules can be thought of as worker modules with respect to the associator 307. They may each act as an "originator," which sends a request to the associator 307. The associator 307 then will select another worker to act as an "assistant" for that request, based on predetermined preferences. If a preferred worker can not assist with serving the request, the associator 307 might try another worker. For example, if utility module 309 has data to forward to utility 106, it would request a connection to the utility 106 from the associator 307. The associator 307 then might request a connection to the utility 106 from WAN module 310. If WAN module 310 is not successful, WAN module 310' might be used. This process will be described more fully with reference to Figures 7A - 7D. In certain

embodiments, such as when HCS 101 is serving strictly as a utility telemetry device, LAN modules 313 and 313' and LANs 204 and 204', collectively LAN function set 312, are optional.

Figures 1 - 3 illustrate the HCS with respect to a utility application. Although the utility application has been disclosed independently from other applications, it should be understood that there can be a great deal of functional interaction among the applications which allows for sharing of components there between in the preferred embodiment. In a given installation of HCS 101, other application modules 312 can be co-resident or alternatives to the utility application, either on the HC bus 308 or on LANs 204 and 204'. Applications that can be hooked up with the HCS 101 can include (but are not limited to): child tracker module, smart home module, utility meter reading module, energy management module, access control module, alarm module, CATV module, and PCS / home telephone module. All applications are workers. Any given application can send and receive data from any other suitable application under the auspices of the associator 307.

Referring to Figure 4, associator 307 includes a processor 402 that is controlled by program 403. Functionally, processor 402 can access data storage 404, where tables are maintained concerning other modules as well as potential external addresses. Associator 307 connects to other modules on the HC bus 308 via its HC bus interface component 405 and physical interface 406. In the preferred embodiment, the HC bus interface component 405 is configured to receive signals from wired links and from wireless links, and would include an antenna and transceiver (not shown) for receiving and

processing rf signals received over-the-air. Processor 402 can be one of several processors readily available on the market today, such as an Intel i960 or a Motorola 6809. Processor 402 could be either a complex instruction set computer (CISC) or a reduced instruction set computer (RISC), general purpose computer or embedded controller. The critical portions of program 403 and data 404 are described more fully with reference to Figures 7A - 7D, 8, and 9A - 9F. Program 403 and Data 404 can be housed in one or more of the varieties of computer memories readily available on the market today, such as static random access memory (SRAM), dynamic random access memory (DRAM), programmable read-only memory (PROM), erasable PROM (EPROM), electrically erasable PROM (EEPROM), Flash Cards, diskette, hard drive, or SmartCards.

Figure 5 is a conceptual depiction of the components of a typical worker 501. Utility module 309, application module 312, WAN modules 310 and 310', and LAN modules 313 and 313' (see Figure 3) are examples of worker modules. A typical worker 501 will be able to act as either an originator or as an assistant. Referring back to Figure 5, worker 501 contains a processor 502 and is controlled by a program 503. Functionally, processor 502 has access to data storage 504 which can store data before and after it is processed. Worker 501 is connectable to other modules on the HC bus 308 by its HC bus interface 505 and physical interface 506. Typically, worker 501 connects to equipment specific to its function via an interface module 507 and a physical interface 508. The HC bus interface 505, in a like manner to HC

bus interface component 405, has the capability to receive signals over-the-air and/or from a wired connection.

Each worker 501, at a minimum, must have access to the functionality of processor 502, program 503, and data 504. Physically, however, processor 502, program 503, and data 504 can be located on a separate plug-in module on the HC Bus 308. For example, associator 307 could share its processor 402 and the physical memory for program 403 and data 404 with processor 502, program 503, and data 504 of worker 501. Interface module 507 and associated physical interface 508 are optional for the worker 501. Further, worker 501 could optionally have multiple interface modules.

In the case of utility module 309, interface 508 could be a CEBus or could be an RS-232 cable, and interface module 507 could include an universal asynchronous receiver transmitter (UART) with a pair of 1488 /1489 line drivers. Alternatively, interface module 507 could include an antenna and a transceiver for receiving and sending signals over-the-air, or it could include a UART, line drivers, an antenna and a transceiver. Program 503 might stipulate little more than periodic reading and forwarding of usage data to utility 106 with data 504 providing a place to temporally store the usage data.

In the case of WAN module 310, a suitable modem could be connected via an RS-232 cable 508 or the modem could be incorporated internally. Program 503 in this case would be communications software. The communications software is used for setting up the connection to the designated destination, monitoring connection conditions, packaging the data stream as necessary, and providing a level of data transmission integrity

assurance. Additionally, LAN module 313 might have the equivalent of a network interface card and protocol translation software.

In some embodiments of worker 501, interface module 507 may support an alternate connection to another worker or multiple workers, such as when a second bus is installed. Physical interface 508 in this case would have a connection to a corresponding physical interface and interface module on the other worker(s).

Figure 6 shows a home having several different types of modules hooked up in a network configuration, in a network using the HCS 101 according to the invention. In this system, a utility module 309, a child tracker module 613, a personal security module 609, a cable response module 611, a home security module 615, and a house control module 627 are all connected to HC bus 308. Associator 307 provides the necessary connection decisions for each of these modules as they seek to communicate with one another or the HCS 101, and it can provide a means to allow some or all of these modules to added or released from the home network gracefully.

The child tracker module 613 is shown as provided with a wireless connection to a radio component 621 that can be attached to a child (not shown), in order to determine the whereabouts of the child at any given time. The cable response module 611 is used to provide user interaction with cable TV channels displayed on a television set 623 (e.g., provides a means for interactive home shopping). The home security module 615 provides the control of a security device (or devices) 625 or 625' in the home. Associator 307 can associate two modules over HC bus 308. For example, security

device 625 or 625' may want to communicate with child tracker module 613. The house control module 627 provides control of energy management functions for the home, and is shown connected to an energy management device 617 or through LAN 204 to energy management device 617'. The utility module 309 is shown connected to a meter 107. The utility module 309 receives data from the meter 107, collects that data, and then sends that data periodically to a utility (not shown in Figure 6). Both HCS 101 and the utility are connected by at least one WAN, such as WAN 203. The specific WAN over which the data will be sent is selected by the Associator 307. The utility receives the data in order to determine an energy bill to be sent to the homeowner. The homeowner may view the bill on TV 623 or PC 631 on LAN 204. The personal security module 609 is connected via a wireless link to a personal security device 630, which can be quickly activated by a user.

Figures 7A - 7D depict a flow chart of the basic process which takes place in HCS 101 when a worker, acting as an originator, sends a requests to associator 307 for connection to either a local or a distant application or host (the destination). When an originator is ready to submit a request (step 702), the originator interrupts the associator 307 (step 703). If associator 307 fails to acknowledge the interrupt (in step 704) then the originator decides whether or not it is ready to try again (step 702). Failure to acknowledge an interrupt may occur, for example, when the associator 307 is currently processing a request from another originator.

If associator 307 does acknowledge the interruption (Path YES in step 704), then the originator forwards the request to associator 307 for

consideration (step 705). Associator 307 receives the request (step 706) and queries an association table 801 (step 707). If there is no result table to serve the request (NO in step 708), then associator 307 notifies the originator (steps 709 and 710), and it is again up to the originator to re-request for connection to the distant application or host (step 702) at a later time. Association table 801 and results tables are more fully discussed with reference to Figures 8 and 9A - 9F.

If associator 307 finds a result table for the request (YES in step 708), then associator 307 checks whether or not the request is for connection (step 713). If the request is not for connection, then the request is for a results table which associator 307 sends to the requesting "smart" originator (step 712). Upon receiving the results table (step 714), the "smart" originator determines whether or not there is an acceptable choice in the results table (step 715). If the results table does not contain an acceptable choice, then the "smart" originator decides whether or not to try again or to modify the request (step 702).

If there is at least one acceptable choice in the results table, then the "smart" originator chooses the best result from the table (step 716), and the originator creates a connection request (step 717). The originator then decides whether or not it is ready to try again (step 702).

If a request is from a "dumb" originator, then that request would always be for connection, since the "dumb" originator is not capable of determining a "best" connection from a results table that it would otherwise receive from the associator 307.

If the request is for a connection (YES in step 713), then the associator 307 selects the first assistant from the results table (step 711). Associator 307 interrupts the selected assistant (step 718). If the selected assistant fails to acknowledge the interruption (step 719) and there is another entry in the results table (step 722), then the associator 307 returns to look for another assistant entry for that request (step 721). If there is not another entry in the results table (NO in step 722) then, again, associator 307 notifies the originator (steps 709 and 710), and it is again up to the originator to re-request (step 702) at a later time.

If the selected assistant acknowledges the interruption (YES in step 719), then associator 307 sends, and the assistant receives, the selected connection data corresponding to the originator's request (steps 720 and 723). The assistant can then decide if it can connect to the destination (YES in step 724). If it can not, associator 307 is sent and receives (steps 727 and 728) notification to look for another assistant (step 722). If the assistant could setup the requested connection (in step 724), then the assistant sets-up the connection to the destination (step 725), and the associator 307 is so informed (step 726).

Associator 307 then can connect the originator and the successful assistant (step 729), inform them both of the connection and receive acknowledgment back (step 730 and 731). At this point, associator 307 is done with processing the request (of steps 705 and 706), and is free to process new requests. The originator can now initiate a session with the requested destination (step 732). The originator and destination exchange information (step 733) while the assistant transparently performs whatever error checking

and other communications link processes are desired. When the originator and the destination have concluded (step 734), the process starts over.

In the case of the utility application, when new usage data is available from the utility module 309, the software interface of utility module 309 can request a connection to a destination from associator 307 (steps 702 - 706). Associator 307 then can facilitate a connection between the software interface of utility module 309 and the software interface of the selected WAN module 310 (steps 707 - 731). The new usage data then can be forwarded by the WAN module 310 from a data storage component previously selected by the utility module 309 and sent out over the WAN 203 (steps 732 - 734). Any processing or manipulations of the data would have been performed by the utility module 309 prior to the initiation of its connection to the WAN module 310 via the associator module 307.

Figure 8 shows the potential contents of a key data table of HCS 101, the association table 801. The association table stores the rules governing connectivity to the modules and networks. It will be understood by those skilled in the art that the connectivity rules could also be embodied in algorithms executed by the associator or in any other form which can be interpreted by the associator.

Association table 801 is the table referenced in step 707 of Figure 7, where the associator 307 performs a query based on a request. The association table 801 is physically stored in data 404 of associator 307. Alternatively, the association table 801 may be stored in an external location, and in which case the association table 801 must be accessed by the associator 307 via a (wired

or wireless) communications link. In either case, updates to the association table 801 can be readily made, either by the associator 307 or by an external system.

Each row, 807 - 821, in association table 801 indicates a connection which associator 307 can facilitate. The connection can be from an application (such as utility module 309) to a remote destination (such as might be on WAN 310 or WAN 310'), as in rows 819-820, or the reverse direction as in row 821. The connection can involve any two workers or a worker and the associator. Column D 802 contains symbolic destination names. Column L 803 contains level of service qualifiers such as important, high, medium, low, backup, and cheap. Column N 804 contains network type identifiers. The assistant name in column S 805 also identifies a worker which can act as an assistant to provide the indicated connection. Associator 307 can also be an originator or assistant in this context (as in rows 815 - 818). Column A 806 contains the address by which the corresponding assistant of column S 805 knows the destination of column D 802.

Association table 801 is updated by the associator 307 every time an application is added to or removed from HCS 101. This update is accomplished by either the new application or the associator 307 contacting a central repository by the same general process as disclosed for any other request. In the case of the associator 307 acting as the originator of the update, the associator 307 issues a request for a connection to "D=HCSNCC." Entries for "D=HCSNCC" are pre-loaded into association table 801 at manufacture to facilitate the initial install and update. The

association table 801 can also be updated by a request being received for "D=AssocTable," in which case associator 307 also acts like a assistant. Such a request might come from a central repository to update the priorities or connection data for a particular destination.

Figures 9A - 9F illustrate, by way of example, the result tables which would be derived from association table 801 for several different requests. Six example requests which an originator might send associator 307 (in step 705) are given (901, 904, 908, 913, 919, and 922). The corresponding result tables (902, 905, 909, 914, and 920) which would be generated as a result of the query by associator 307 (in step 707), given association table 801, are presented. A request can contain destination (D), level of service (L), net (N), assistant (S), and/or address (A) fields in any order. The order of the fields in the request determines both the index order and the order of the columns in the result table.

Figure 9A illustrates the result of a request 901 with D, L and N specified. Figure 9B illustrates the result of request 904 which is a less restrictive form of request 901. Request 908 of Figure 9C illustrates, when contrasted with 9B, how the fields specified in a request impact the order of the result table columns, as well as the association table 801 rows selected. Figure 9D includes the results table 914 from a single field request. The null results table 920 of Figure 9E is generated from a request, 919, which can not be satisfied by association table 801. Figure 9F is an another example of a D and L type request.

The present invention is very flexible. In its capability as a switch, HCS 101 can facilitate network to network connectivity just as easily as network to application, application to network, and application to application where a network could be a WAN or a LAN. The ability to connect networks can be used to provide a connection from a distant location to HCS 101 which can then pass the connection to another network for connection to other HCS units in its local area. For example, a utility might have a leased line to a given HCS which then acts as a cell site for connectivity via a local RF WAN to other HCS units with which it needs to connect. This capability could also be used to provide a neighborhood phone system or provide a backup to a network segment.

It is readily apparent to those of ordinary skill in the art that there is not a requirement to have multiple WANs (203 and 203') for HCS 101. One low bandwidth application would likely require just a single WAN 203. If a wide-bandwidth WAN 203 is available to HCS 101, such as might be provided by a fiber or coax cable network, then all HCS 101 applications might be funneled onto a single WAN 203.

HCS 101 can be housed in a variety of system enclosures, depending on the needs of the particular configuration being installed. In a minimal installation, the associator 307, and two worker modules, such as utility module 309 and WAN module 310, might be housed in a single enclosure external to the house 102. As the requirement developed, additional enclosures might be added to contain additional worker modules, and possibly even second-tier associator modules. These additional housings would then be

connected to the first so as to make the physical separation transparent to the modules.

While a preferred embodiment of the invention has been described herein, modification of the described embodiment may become apparent to those of ordinary skill in the art, following the teachings of the invention, without departing from the scope of the invention as set forth in the appended claims.

For example, the HCS 101 may be configured to handle disconnections as well as connections for the home network. In such a case, for example, a module that is already hooked up to the home network may want to be released from the home network. In this situation, the module would send an interrupt signal to the associator, in which it would desired to request to be disconnected from the network. Upon receiving this request for disconnection signal, the associator would send either a request accepted or a request denied signal back to the originator, similar to the method as illustrated in Figures 7A - 7D. If the associator allows the originator to disconnect from the network, then the associator would update its association table accordingly.

What is claimed is:

1. An apparatus for controlling access to a plurality of communication networks by a plurality of modules, comprising:

input/output means for receiving a request for connection signal from a module desiring to make a connection through said communication networks;

a data storage area for storing rules governing access to said plurality of networks; and

an associator connected to said input/output means and said data storage area to determine an appropriate one of said communication networks to be used to service said request based on said rules, and for providing access to said one of said communication networks.

2. The control apparatus according to claim 1, further comprising:

an association table stored in said data storage area and configured to store said rules governing access to said plurality of networks.

3. The control apparatus according to claim 1, further comprising:

means for updating said rules based on an update signal received from an external device.

4. The control apparatus according to claim 1, wherein said rules include destination addresses which can be reached through each of said communication networks and priority information for each of said communication networks indicating a priority of use of each of said communication networks for connecting to said destination addresses.

5. The control apparatus according to claim 1, wherein said request for connection made by said device may be one of a request for a wide area

network connection through said communications network and a request for a local area network connection through said communications network.

6. The control apparatus according to claim 1, wherein said communication networks include a local area network (LAN) and a wide area network (WAN) and said modules include LAN module and a WAN module.

7. A network of modules for use in a home environment, comprising:

a plurality of worker modules each providing differing functions in the home environment; and

an associator connected to said worker modules and connected to at least one external network for providing access between said worker modules and said external network, said associator allowing two-way communication between said modules and said external network;

wherein said worker modules may send a request for access to an external network to said associator, and said associator includes means for evaluating said request for access and either grants said request for access or responds with a denial of said request for access.

8. The network according to claim 7, wherein said network of modules includes:

a child tracker worker module for determining a location of a child within a particular range with respect to the child tracker worker module;

an energy management worker module for providing energy control of the home environment based on user-inputted commands;

a home security worker module for monitoring a perimeter of the home environment and for providing an alarm indication upon detection of an object at the perimeter; and

a utility worker module for receiving input from a particular utility meter within the home environment, and for collecting and outputting the received input at predetermined times.

9. The network according to claim 7, wherein said associator is connected to a plurality of external networks and stores rules for accessing each of said external networks, and wherein said associator responds to said request for access by determining which of said external networks is most appropriate to provide the requested access based on said rules.

10. The network according to claim 7, further including an internal data bus connecting some of said worker modules, said internal data bus being a wireless data link, and in which each of said worker modules and said associator module are provided with a respective antenna and a transceiver for communicating with each other over the wireless data link.

11. The network according to claim 7, further including an internal data bus connecting some of said worker modules, said internal data bus being a wired data bus, and in which each of said worker modules and said associator module are provided with a wired bus interface for communicating with each other over the wired data bus.

12. The network according to claim 7, wherein said rules include destination addresses which can be reached through each of said external networks and priority information for each of said external networks indicating

a priority of use of each of said external networks for connecting to said destination addresses.

13. The network according to claim 9, wherein said plurality of external networks include at least one local area network (LAN) and at least one wide area network (WAN).

14. A method for determining access by a home network of modules to a plurality of destinations on external networks, comprising the steps of:

a) sending a request signal by a requesting module to a control module in the home network to request information related to a connection to one of said plurality of destinations;

b) determining, at said control module, whether said information relating to said connection is available by referring to an association table which contains information related to available connections to said home network; and

c) sending a response to said requesting module based on the availability of said information.

15. The method according to claim 14, wherein said association table includes destination addresses, addresses of assistant modules that are needed to set up a connection to a particular one of said external networks, and a priority indication with respect to a corresponding desired connection.

16. The method according to claim 14, wherein said request signal includes data indicating a priority level of said request and a destination address.

17. The method according to claim 14, wherein the step of sending a response comprises:

d) sending a result table which includes all available connections to said requesting module in order for said requesting module to determine a best connection to said destination.

18. The method according to claim 14, wherein said one of said plurality of destinations is one of said modules in said home network of modules.

19. The method according to claim 17, wherein said request signal is for connection to a destination on one of the available networks.

FIG. 1

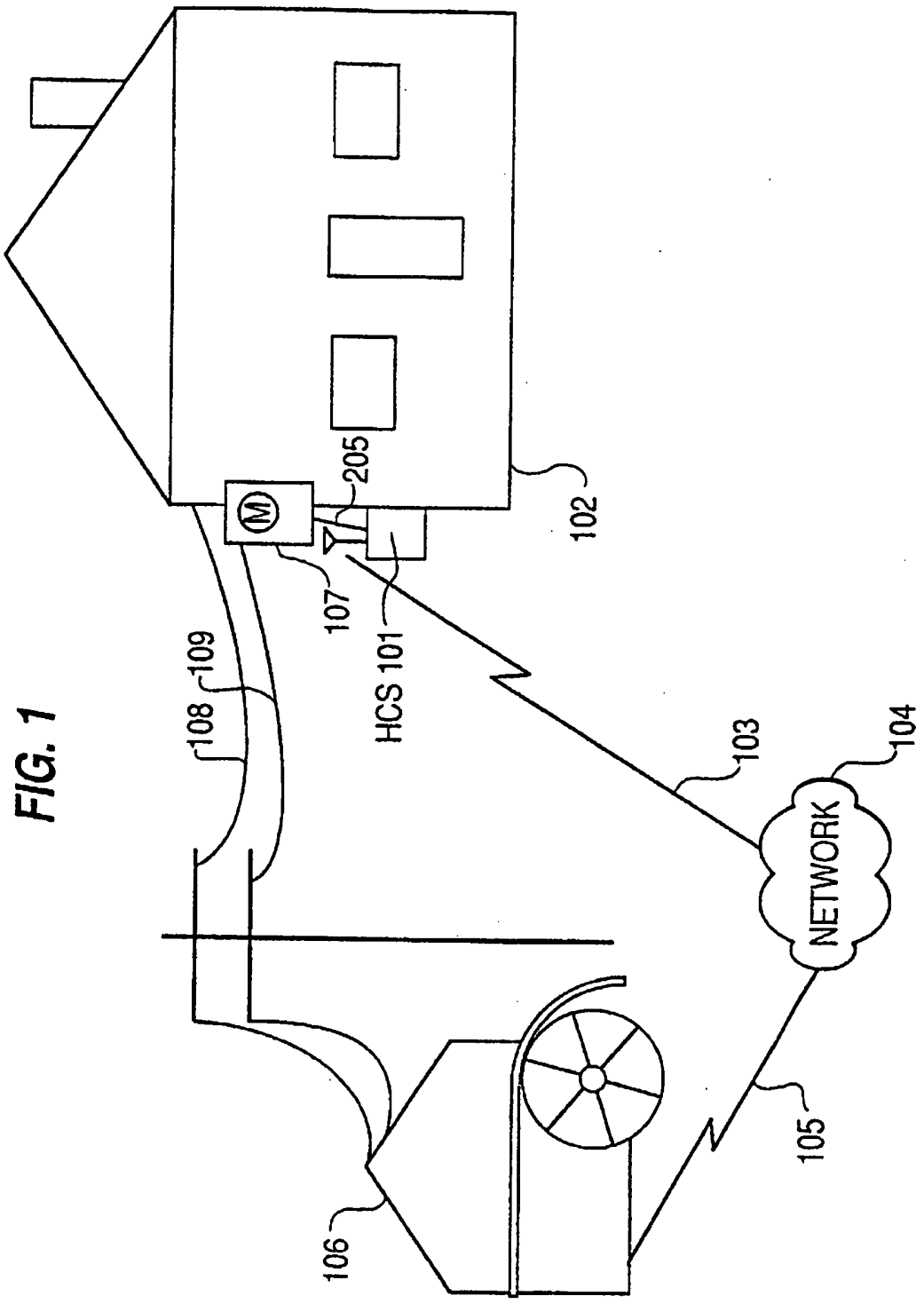


FIG. 2

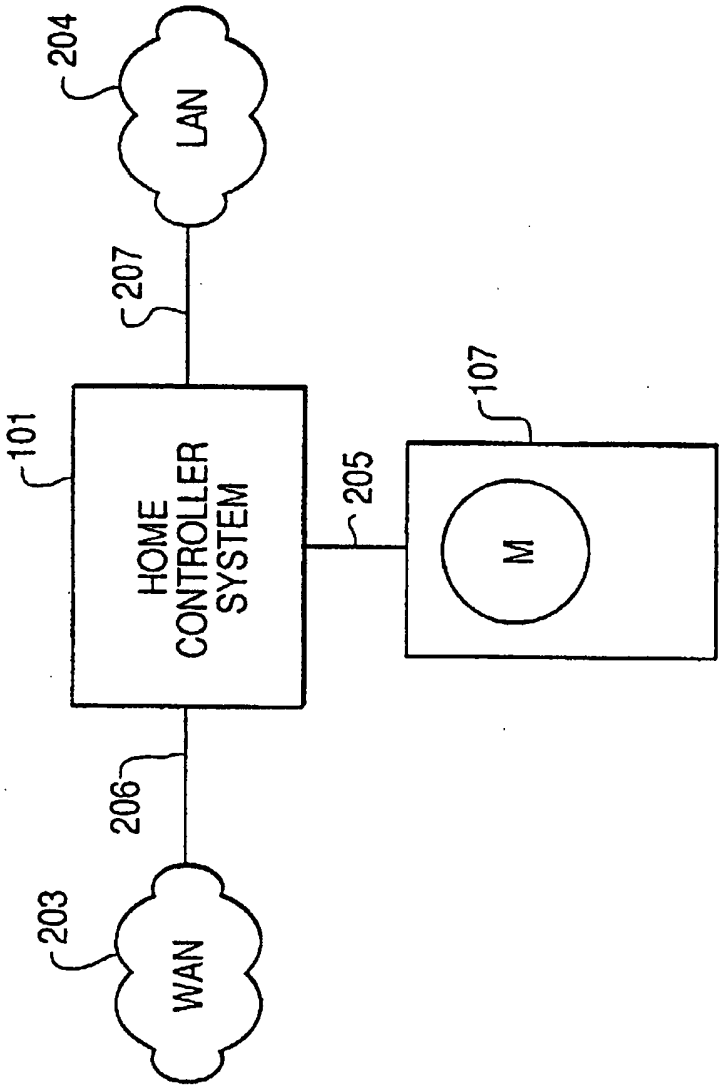


FIG. 3

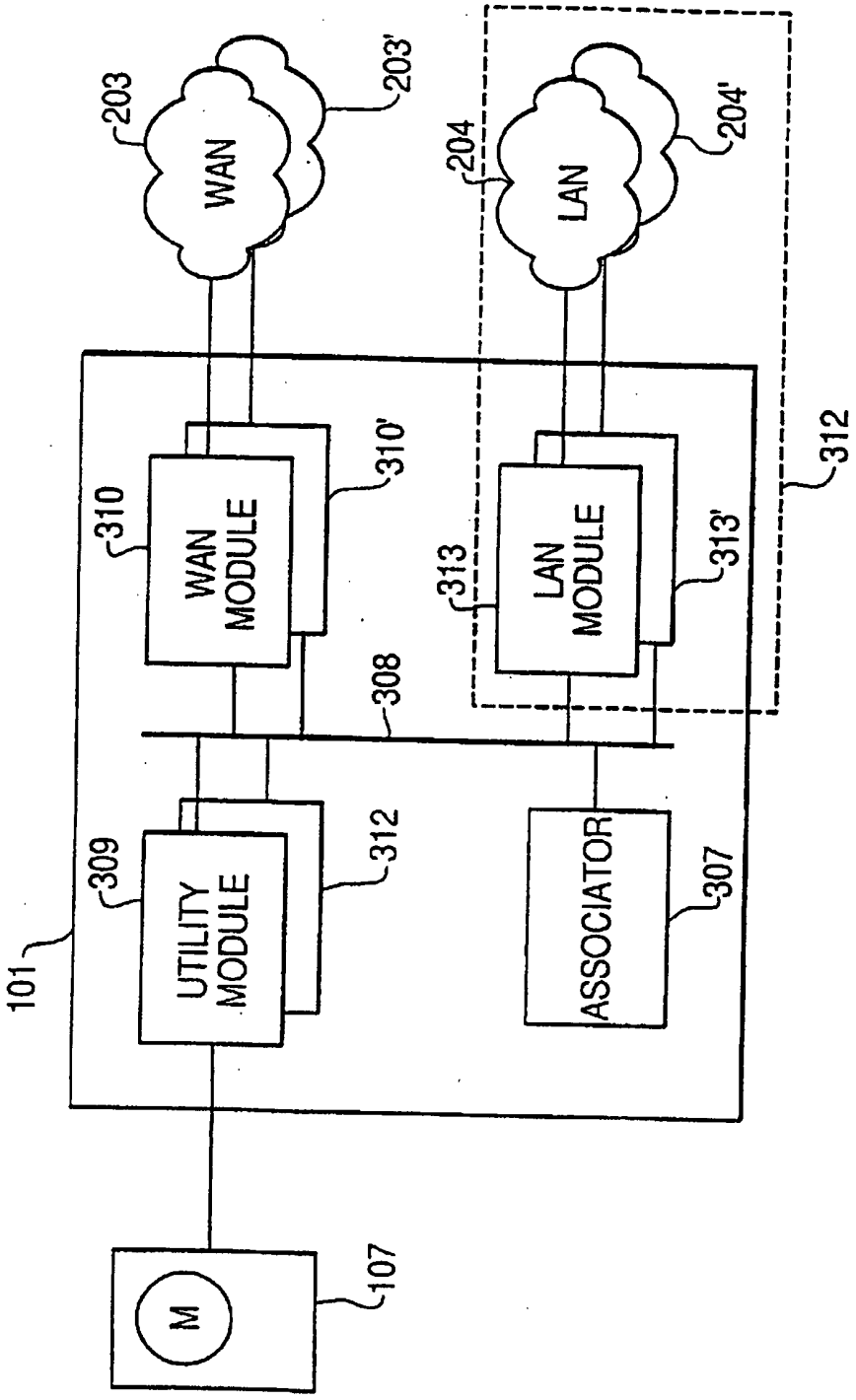

203
WAN
203'
204
LAN
204'
310
WAN MODULE
310'
313
LAN MODULE
313'
312
308
309
UTILITY MODULE
312
ASSOCIATOR
307
101
M
107

FIG. 4

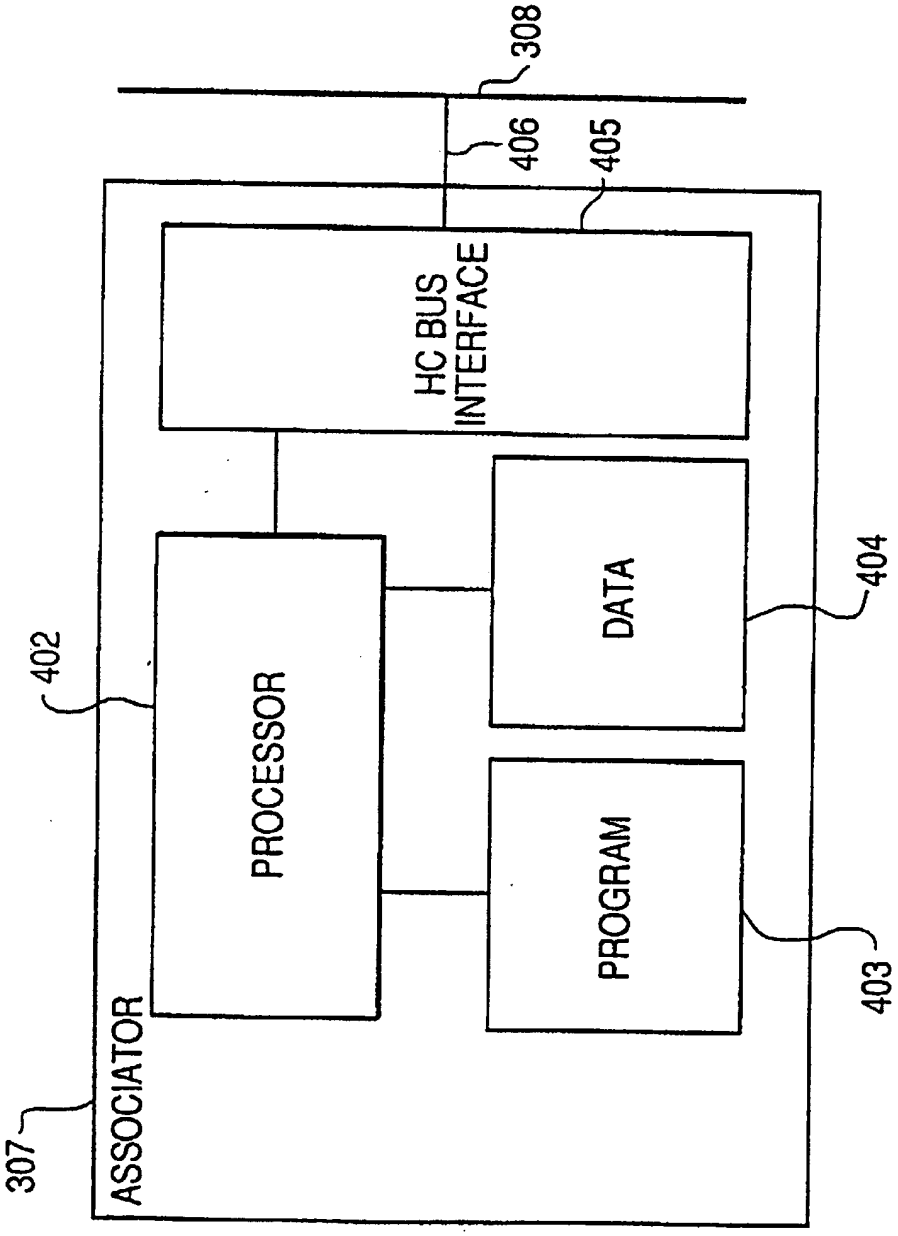

308
406
405
HC BUS INTERFACE
DATA
404
PROCESSOR
402
PROGRAM
403
ASSOCIATOR
307

FIG. 5

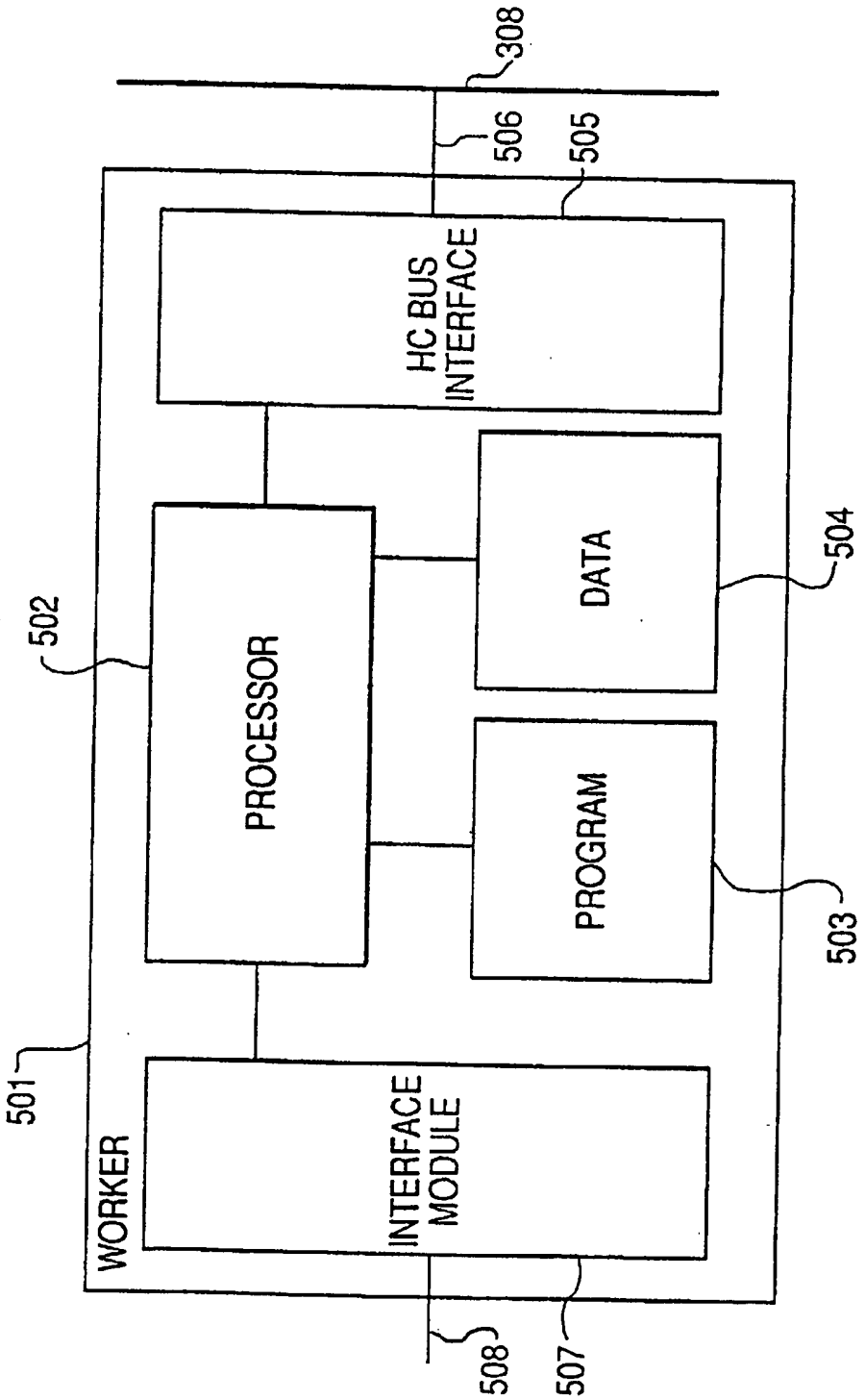

308
506
505
HC BUS INTERFACE
DATA
504
PROCESSOR
502
PROGRAM
503
501
WORKER
INTERFACE MODULE
508
507

FIG. 6

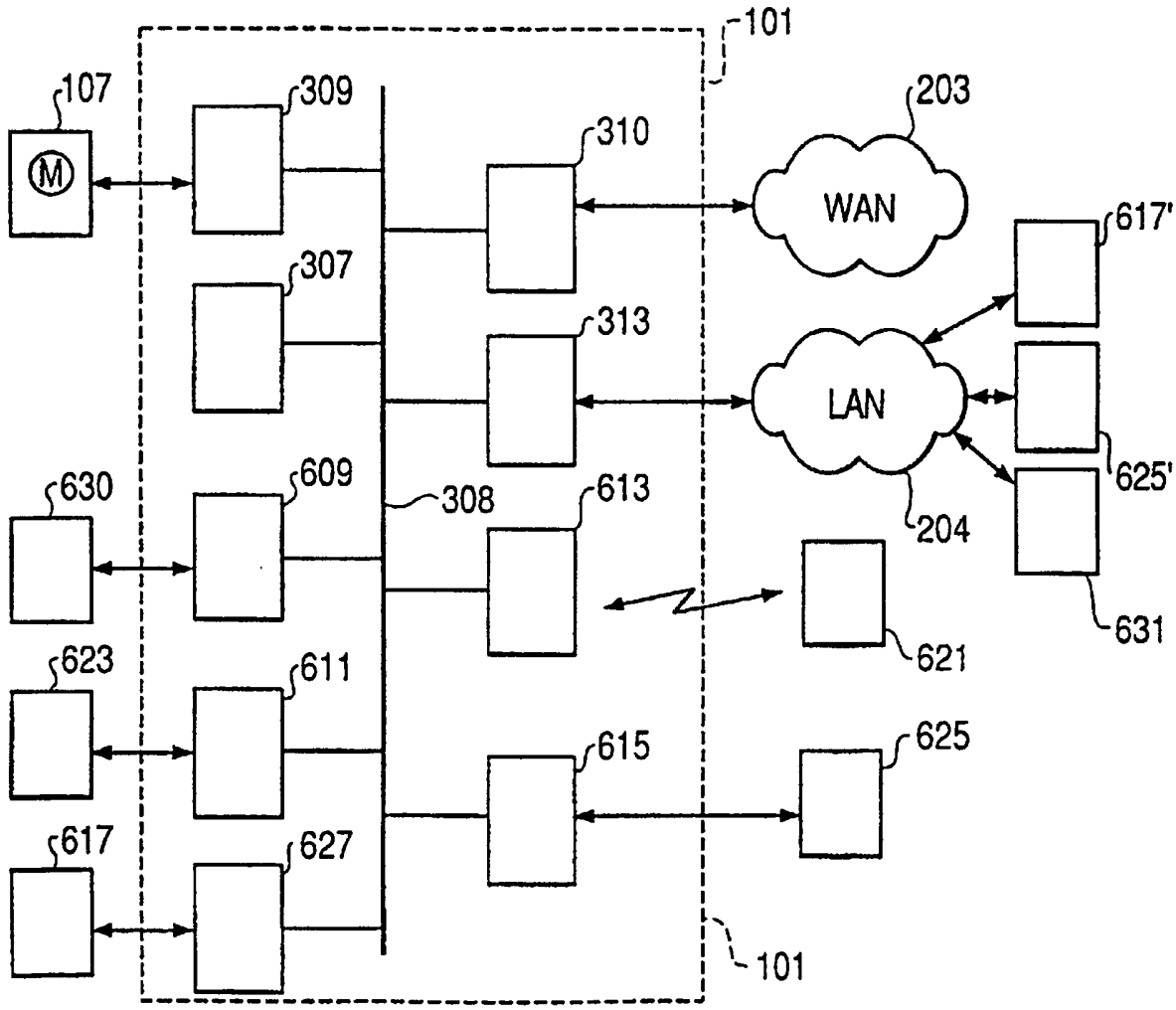

101
107
309
310
203
WAN
307
313
617'
LAN
630
609
308
613
625'
204
631
623
611
621
615
625
617
627
101

FIG. 7A

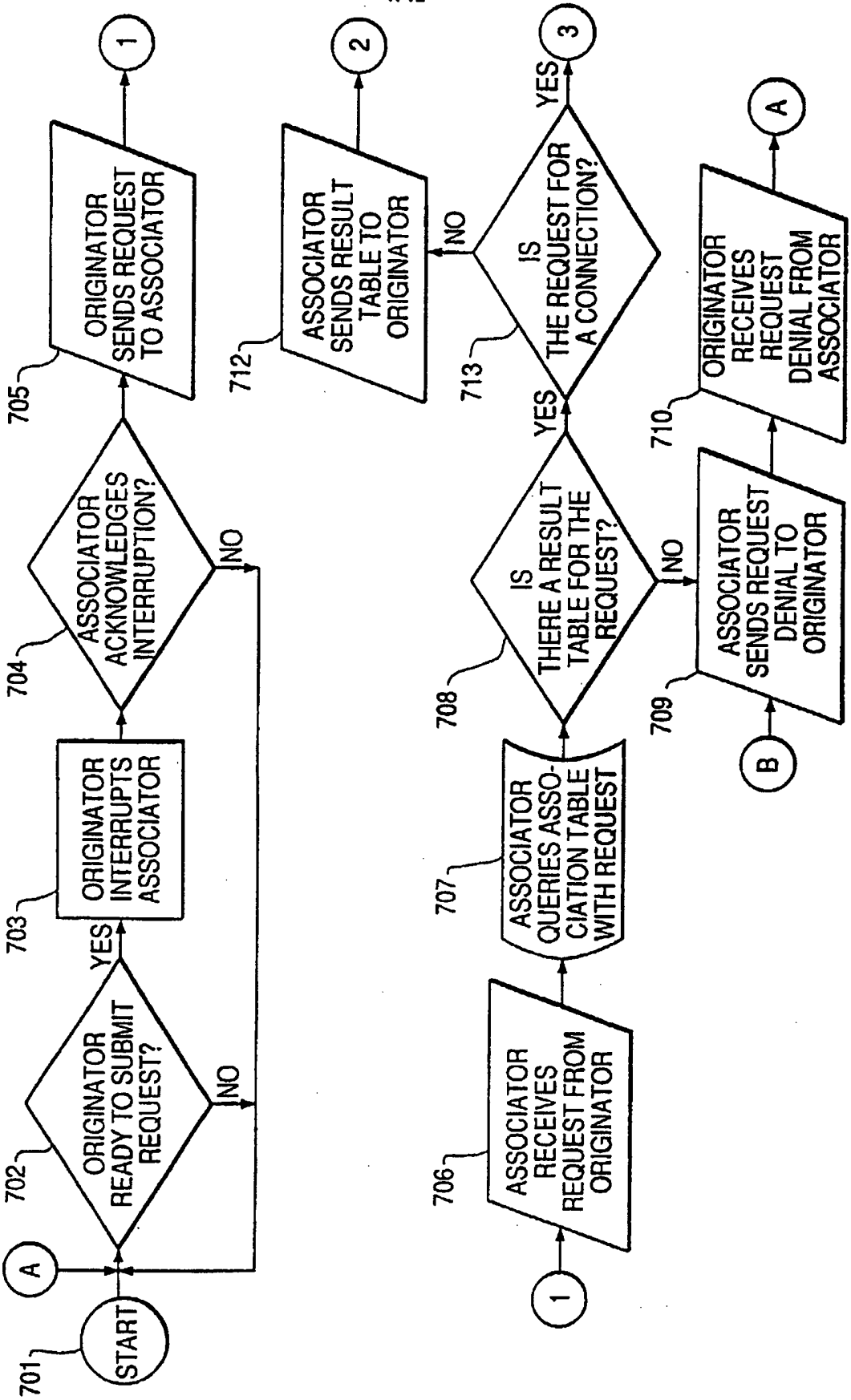
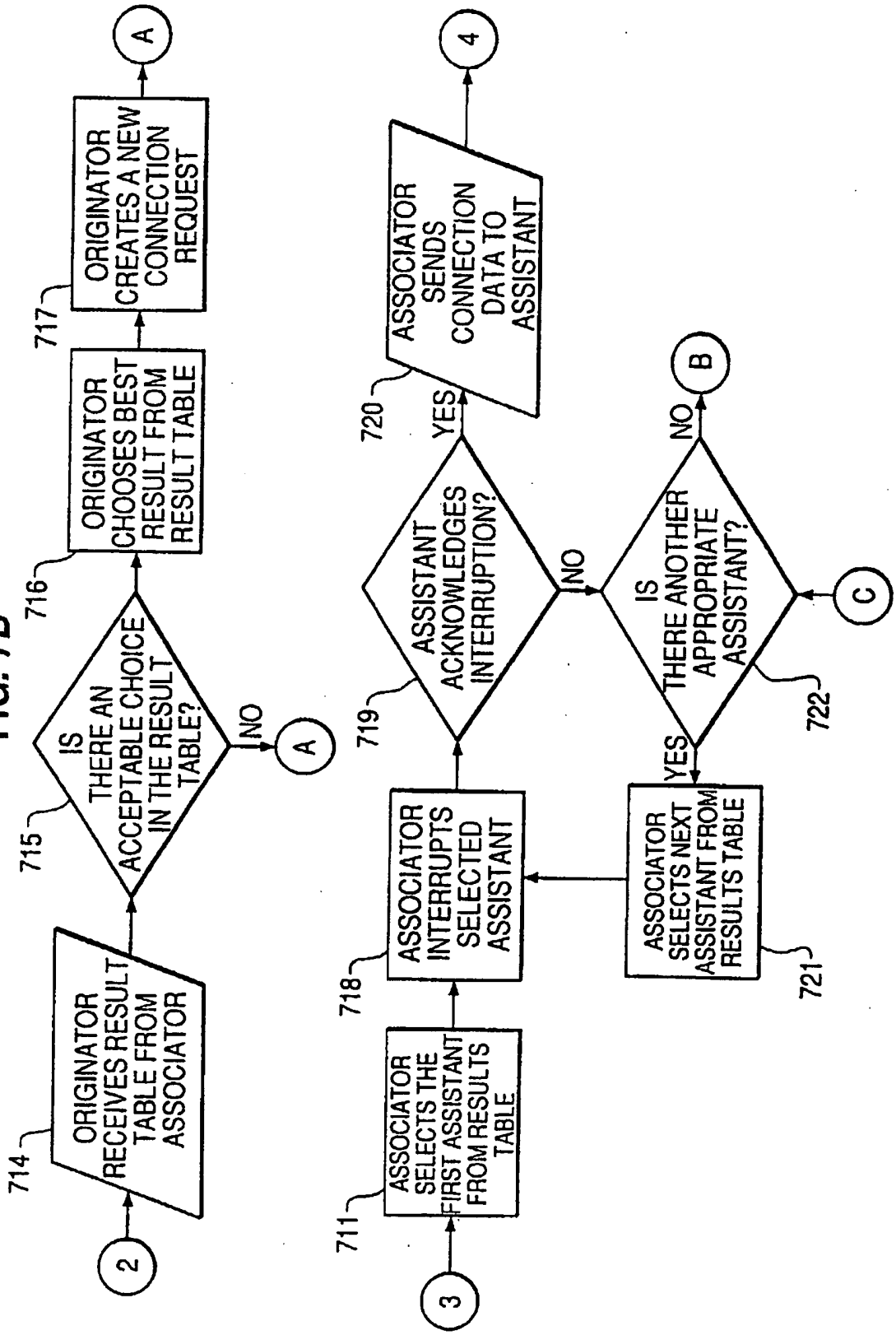

701
START
A
702
ORIGINATOR READY TO SUBMIT REQUEST?
YES
NO
703
ORIGINATOR INTERRUPTS ASSOCIATOR
704
ASSOCIATOR ACKNOWLEDGES INTERRUPTION?
YES
NO
705
ORIGINATOR SENDS REQUEST TO ASSOCIATOR
1
706
ASSOCIATOR RECEIVES REQUEST FROM ORIGINATOR
1
707
ASSOCIATOR QUERIES ASSOCIATION TABLE WITH REQUEST
708
IS THERE A RESULT TABLE FOR THE REQUEST?
YES
NO
709
ASSOCIATOR SENDS REQUEST DENIAL TO ORIGINATOR
B
710
ORIGINATOR RECEIVES REQUEST DENIAL FROM ASSOCIATOR
A
713
IS THE REQUEST FOR A CONNECTION?
YES
NO
3
712
ASSOCIATOR SENDS RESULT TABLE TO ORIGINATOR
2

FIG. 7B


2
714
ORIGINATOR RECEIVES RESULT TABLE FROM ASSOCIATOR
715
IS THERE AN ACCEPTABLE CHOICE IN THE RESULT TABLE?
NO
A
716
ORIGINATOR CHOOSES BEST RESULT FROM RESULT TABLE
717
ORIGINATOR CREATES A NEW CONNECTION REQUEST
A
3
711
ASSOCIATOR SELECTS THE FIRST ASSISTANT FROM RESULTS TABLE
718
ASSOCIATOR INTERRUPTS SELECTED ASSISTANT
719
ASSISTANT ACKNOWLEDGES INTERRUPTION?
YES
720
ASSOCIATOR SENDS CONNECTION DATA TO ASSISTANT
4
NO
IS THERE ANOTHER APPROPRIATE ASSISTANT?
722
NO
B
C
YES
ASSOCIATOR SELECTS NEXT ASSISTANT FROM RESULTS TABLE
721

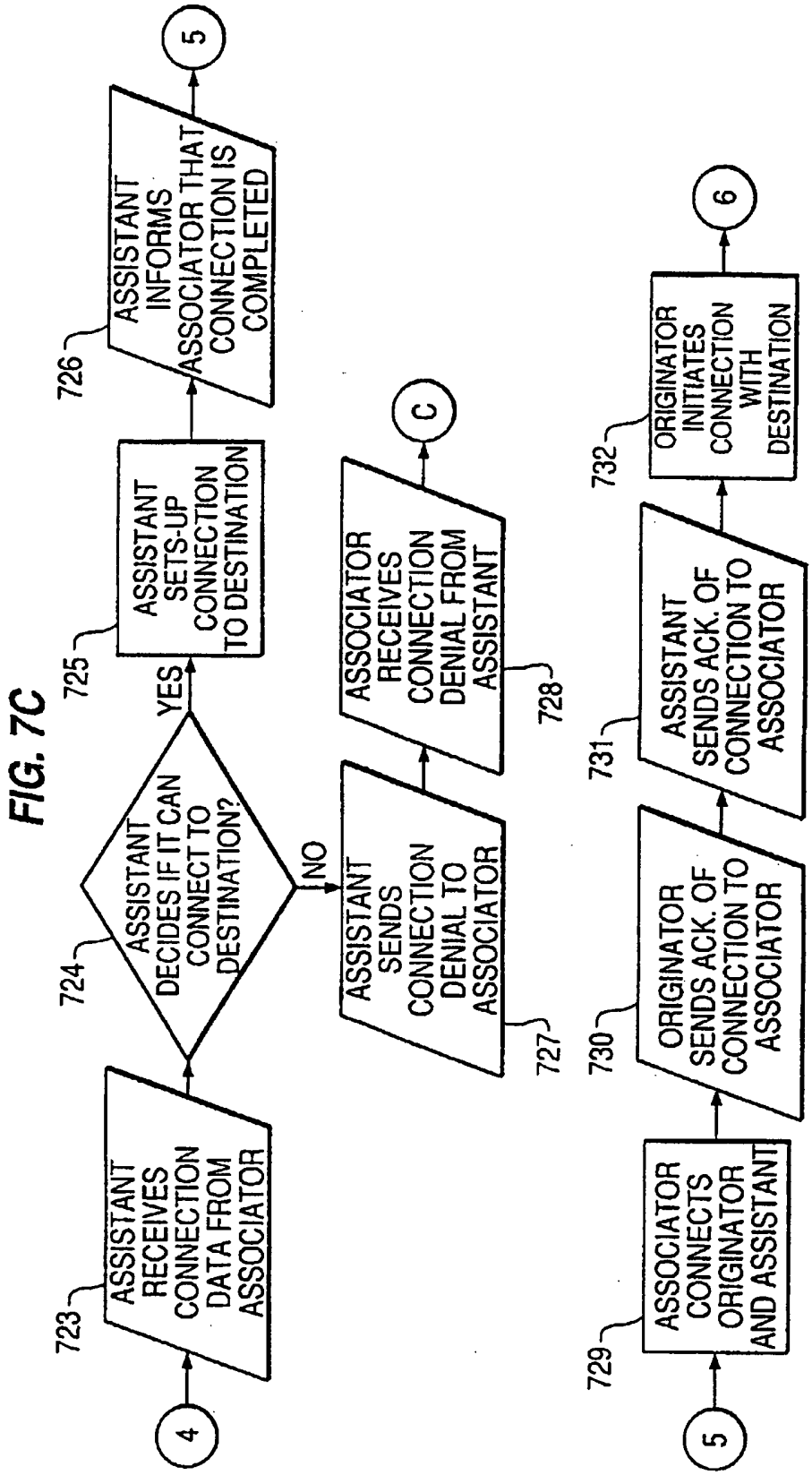

4
723
ASSISTANT RECEIVES CONNECTION DATA FROM ASSOCIATOR
724
ASSISTANT DECIDES IF IT CAN CONNECT TO DESTINATION?
YES
NO
725
ASSISTANT SETS-UP CONNECTION TO DESTINATION
726
ASSISTANT INFORMS ASSOCIATOR THAT CONNECTION IS COMPLETED
5
727
ASSISTANT SENDS CONNECTION DENIAL TO ASSOCIATOR
728
ASSOCIATOR RECEIVES CONNECTION DENIAL FROM ASSISTANT
C
729
ASSOCIATOR CONNECTS ORIGINATOR AND ASSISTANT
5
730
ORIGINATOR SENDS ACK. OF CONNECTION TO ASSOCIATOR
731
ASSISTANT SENDS ACK. OF CONNECTION TO ASSOCIATOR
732
ORIGINATOR INITIATES CONNECTION WITH DESTINATION
6

FIG. 7C

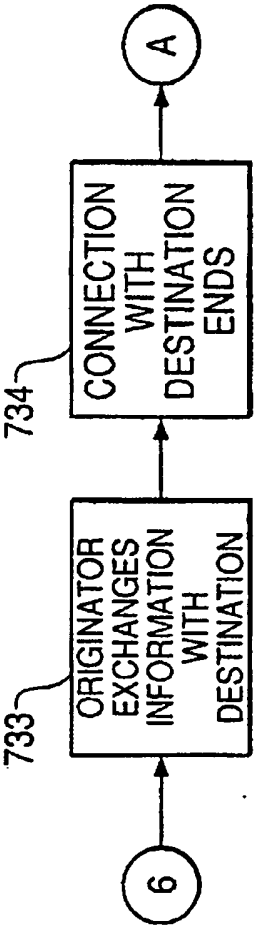

6
733
ORIGINATOR EXCHANGES INFORMATION WITH DESTINATION
734
CONNECTION WITH DESTINATION ENDS
A

FIG. 7D

FIG. 8

ASSOCIATION TABLE 801:

	D 802	L 803	N 804	S 805	A 806
807	ALARM CENTRAL	IMPORTANT	RADIOX.25	IVDS	9117030000911
808	ALARM CENTRAL	IMPORTANT	SWITCHED ASYNC	POTS	555-0911
809	ALARM CENTRAL	IMPORTANT	CATV, CH. 4	COAX	856970184
810	ALARM CENTRAL	BACKUP	CATV, CH. 5, IP	COAX	911@alarms.com
811	AOL, TERMINAL	LOW	SWITCHED ASYNC	POTS	555-0300
812	AOL, TERMINAL	MED	SWITCHED ASYNC	POTS	555-2400
813	AOL, TERMINAL	HIGH, CHEAP	RADIO,X.25	IVDS	31121250000123
814	AOL, TERMINAL	HIGH	SWITCHED ASYNC	POTS	555-1440
815	HCSNCC	HIGH, CHEAP	RADIO,X.25	IVDS	59921250000123
816	HCSNCC	BACKUP	CATV, CH. 5 IP	COAX	ncc.oscm.com
817	HCSNCC	BACKUP	SWITCHED ASYNC	POTS	703-255-0346
818	ASSOC TABLE	-NONE-	-NONE-	ASSOC	-none-
819	UTILITY	HIGH, CHEAP	RADIO,X.25	IVDS	62430350000555
820	UTILITY	BACKUP	SWITCHED ASYNC	POTS	555-1346
821	WATER HEATER	-NONE-	-NONE-	METER	DEV1

FIG. 9A

901 REQUEST= D= AOL, TERMINAL L= HIGH N= RADIO,X.25
902 RESULT TABLE:

	D	L	N	S	A
903	AOL, TERMINAL	HIGH, CHEAP	RADIO,X.25	IVDS	31121250000123

FIG. 9B

904 REQUEST= D= AOL, TERMINAL L= HIGH
905 RESULT TABLE:

	D	L	N	S	A
906	AOL, TERMINAL	HIGH, CHEAP	RADIO,X.25	IVDS	31121250000123
907	AOL, TERMINAL	HIGH	SWITCHEDASYNC	POTS	555-1212

FIG. 9C

908 REQUEST= D= AOL, TERMINAL N= SWITCHEDASYNC
909 RESULT TABLE:

	D	N	L	S	A
910	AOL, TERMINAL	SWITCHEDASYNC	LOW	POTS	555-0300
911	AOL, TERMINAL	SWITCHEDASYNC	MED	POTS	555-2400
912	AOL, TERMINAL	SWITCHEDASYNC	HIGH	POTS	555-1440

FIG. 9D

913 REQUEST= D= AOL, TERMINAL
914 RESULT TABLE:

	D	L	N	S	A
915	AOL, TERMINAL	LOW	SWITCHEDASYNC	POTS	555-0300
916	AOL, TERMINAL	MED	SWITCHEDASYNC	POTS	555-2400
917	AOL, TERMINAL	HIGH, CHEAP	RADIO,X.25	IVDS	31121250000123
918	AOL, TERMINAL	HIGH	SWITCHEDASYNC	POTS	555-1440

FIG. 9E

919 REQUEST= D= AOL, TERMINAL L= IMPORTANT
920 RESULT TABLE:

	D	L	N	S	A
921	NULL				

FIG. 9F

922 REQUEST= D= ALARM CENTRAL L= IMPORTANT
923 RESULT TABLE:

	D	L	N	S	A
924	ALARM CENTRAL	IMPORTANT	RADIO,X.25	IVDS	9117030000911
925	ALARM CENTRAL	IMPORTANT	SWITCHEDASYNC	POTS	555-0911
926	ALARM CENTRAL	IMPORTANT	CATV, CH.4	COAX	856970184